THE TELOTYPE,

A PRINTING ELECTRIC TELEGRAPH.

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London:

JAMES RIDGWAY, 169, PICCADILLY;

M^cMILLAN, CAMBRIDGE.

MDCCCXLIX.

LONDON:
PRINTED BY T. BRETTELL, RUPERT STREET, HAYMARKET.

Oxf. & Cambr: Club
Pall Mall London
April 1869.

Sir,
I venture, as a former pupil to send you a proof copy of a pamphlet on the subject of which I have been long occupied. May I beg, if you consider it of sufficient worth, your kind permission to me to dedicate it to you?

Besides a strong wish to acknowledge and testify how much I know myself to be indebted to your

lectures I should feel it a real gratification to be assured that it was not without your approbation & well-wishes that my first public attempt in mechanism was made.

I feel that I have trespassed on your indulgence in writing, for though on my part I look back with pleasure to all the hours spent 5 or 6 years ago in your lecture-room, yet I cannot expect that you will have retained any personal recollection of me.

I have therefore acted on the belief that the relations between pupil & professor might remain such, that I could write, and that you would also pardon my taking the liberty of doing so.

I beg to remain,

very sincerely yours.

Francis Galton.

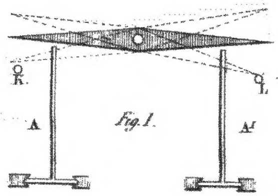
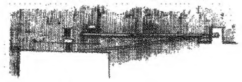


Fig. 1.



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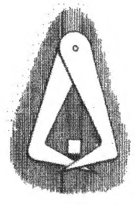

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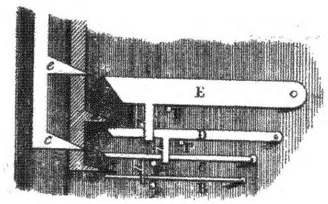

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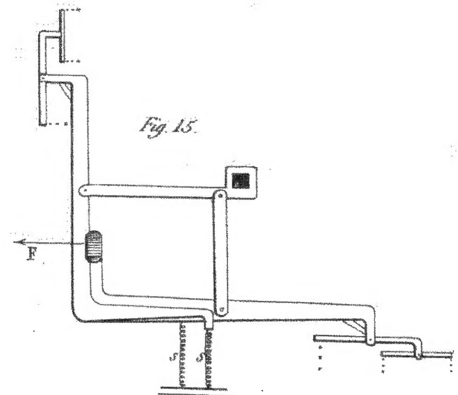

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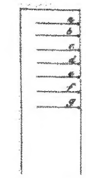

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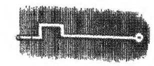

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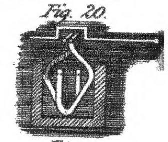

Fig. 21.

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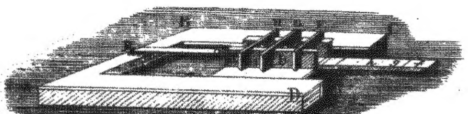

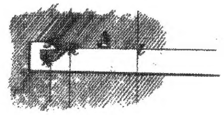

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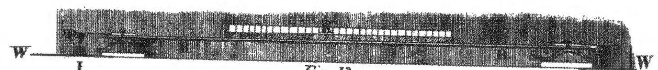

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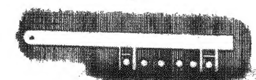
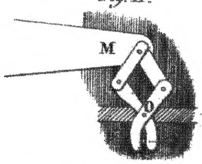


Fig. 14.

Fig. 9.

Fig. 11.



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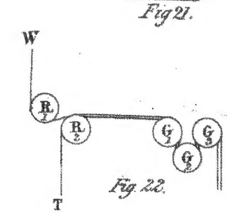

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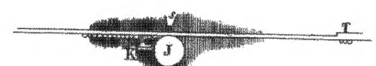

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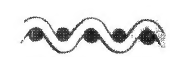
Fig. 23.



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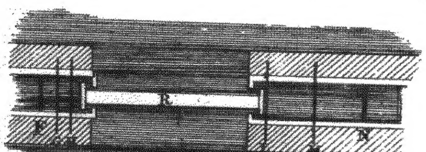

Fig. 12.

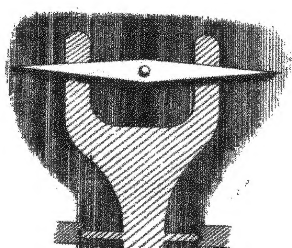

Fig. 10

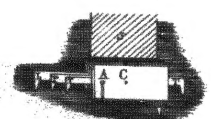

Fig. 19

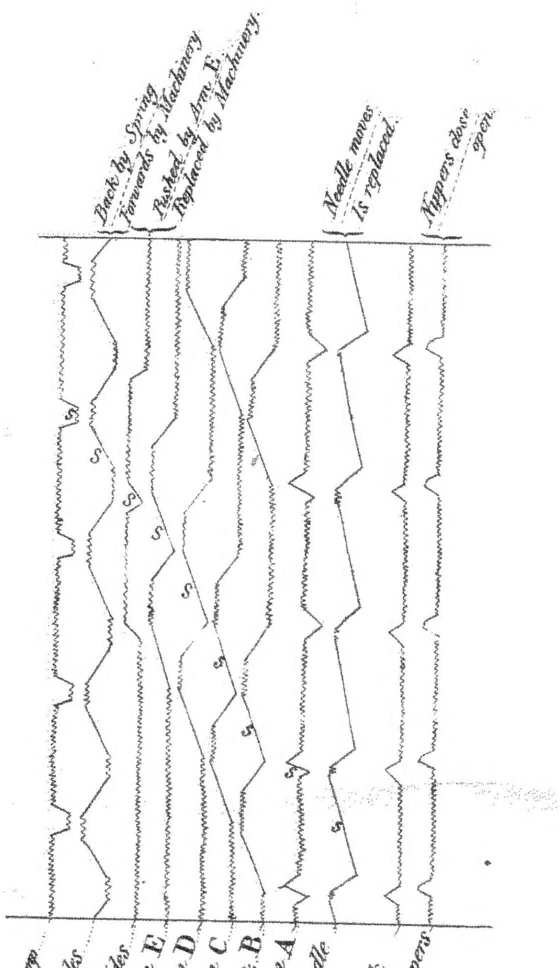
Back by Spring
Forwards by Machinery
Pushed by Arm E
Replaced by Machinery
Needle moves
Is replaced
Nippers close
open
Stamp
Tables
Slides
Arm E
Arm D
Arm C
Arm B
Arm A
Needle
Fork
Nippers

Fig. 7.

THE TELOTYPE,

A PRINTING ELECTRIC TELEGRAPH.

THE force that electricity puts at our disposal, with ordinary batteries, and at a distance, is extremely small. We can make a light well-balanced needle traverse from side to side, one that a breath of air would set spinning on its axis; but how can such a power govern the movements of heavy machinery? It is true that by using a magnetic coil we can lift a detent of some strength, but even so we cannot disengage it with certainty from the teeth of a wheel that is urged by a force sufficient to work a machine of any power and complexity.

The needle has an advantage over the detent in giving three signals, including the position of rest to the two the detent gives; this, and other well-known reasons, not worth recapitulating here, have caused the Needle-Telegraph to out-

rival the Electro-Magnetic one, and would equally induce us also, if we were able to work heavy machinery by either of them, to prefer the latter for our instrument.

Now, there is a method by which either one or the other can be made to govern heavy machinery, but it is a method which has never yet been applied to Telegraphs, nor indeed, as it is believed, elsewhere, though considerable use might be made of it in many ways.

If there be a machine at a distant telegraph station, urged by a weight or other force, it is easy to conceive, and the method of doing so will hereafter be fully explained, that the operator can be made aware of the exact moment of each revolution of the machine. Assuming this for the time, we may consider the distant machine as acting under the operator's eye.

To direct a great force by means of a very small one.

We have then before us, on the one hand, this machinery,—on the other the Needle; our first object is in some way to connect one with the other.

This connection, whatever it is, must evidently be of the most delicate description. It must neither interfere with the free movement of the needle, nor endanger its magnetism or supports.

These conditions are fully satisfied by having a light arm (A and A', fig. 1) as small as the seconds' hand of a watch lying at each end of the needle, and at right angles to it. These are

capable of moving through a small angle in a vertical plane, and the needle swings between the limiting stops (K and L) in the plane of the paper. The arms are moved by the machinery, and in such a manner, that supposing each complete revolution of the machine to take up one second, then during six-eights of that time these arms are supported up, during one-eighth they are let fall, and, again, during one-eighth they are being lifted again. It will be seen by fig. 2, which represents the side of A and the needle N in section, that for the six-eighths of a second, when A and A^1 are up, the needle is perfectly free to move: so the operator chooses that time to make his signal, but when it has elapsed the arms fall; and then if the needle has moved to the stop K fig 1, the arm A will drop upon it and lie there, while the arm A_1 falls freely. The case would have been reversed had the needle moved to L, and had it not moved at all *both* arms would have fallen. We shall see that this check, although acting on so slight a piece of mechanism, and for so short a time, will nevertheless sufficiently connect the machinery and the needle.

It will be made to produce an effect, which, running through a series of arms, each stronger than the one before it, will finally become available, and in the complete machine we shall have a type-holder moving backwards and forwards at

one end, and the needles signalling at the other, both working at equal speed, and the first registering the signals, combined together, and transmitted to it from the last.

It must be added that the method by which the needle is kept from tilting when an arm falls upon it, and much else, will be amply explained hereafter; the subject immediately before us is to show how checking the arm A can result in checking a considerable force.

If arms like those in fig. 3 are constrained to move up and down in a vertical plane, the teeth there represented, pushed under, would evidently raise them; they, on the other hand, will drop when the teeth that raised them are withdrawn. Now, although such teeth will do this, yet others acting across the arm, fig. 4 (where the arm is seen in section), and in opposite directions, will do it much better—the side-action of one tooth counteracting that of the other, while they both concur in lifting. It must, therefore, be clearly understood that the teeth are represented acting as they do in fig. 3, only for the sake of having all the parts of the machine in the same plane, and not as exhibiting the best mechanism. The apparatus (fig. 3) will act extremely well, but another having two teeth acting crossways on each arm would act better, especially for the smaller arms.

Each arm rests on a stop P and has fixed

below it a sort of projecting step (seen in full fig. 5, where E, D, are sections of the arms E, D,) and so made, that if D, for instance, be lifted up it first moves freely, then it strikes against the cross-piece r s, and can only move still further by lifting E together with it; this it cannot do for long, as the stop P which supported E, stops it.

Again, the teeth are so arranged as just to slide over the arms they correspond to, without touching them, when the arms rest on their supporting-stops. Therefore if any one of them be raised a little, and the tooth be pushed forwards, it will engage itself under the arm and raise it up still higher. Now the teeth are constructed so as to be able to raise the arms they stand opposite to nearly as high as the stop above permits them to go. If the rod bearing the teeth b d be drawn back, and B be pushed a little up, b moving forward again, B will be raised still higher, so as itself to raise C. Now let the rod bearing the teeth c, c, advance, c will come in gear with C (while, b retreating, B will fall back again). C, therefore, will now be raised and will push up D, which in its turn will be acted upon by d, and so on. It will be seen that a simple reciprocating movement of the rods that carry the teeth will not suffice, as the advancing tooth would jam the arm it is the cause of raising against the tooth above it. Their

proper movement may be gathered from the table, fig. 7.

In fig. 3, if the arms were to lie across one another, we should not want the projecting step, and the mechanism would be simpler; but the drawing would become so confused as to be of less service.

Now, we see that the weight of any one arm C, and the friction round its axis are the only obstacles B has to overcome in lifting it; but C in its turn may lift as great a weight as it, or the tooth that drives it, can manage without breaking. This last is a very great multiple of the first, and therefore each successive arm may increase considerably in magnitude. If, then, we super-impose arm upon arm, we should attain to prodigious power, and the movement of a mere hair might determine whether or no the heaviest mass that we could deal with by machinery should or should not be lifted. Such a statement is by no means one, that though plausible on paper, is really impracticable, like the undertaking to lever a heavy mass by a feather weight; but, on the contrary, such a machine is perfectly feasible to any one who chooses to undertake the task of making it.

Let E be the last arm of the series—if B be raised, E ultimately will be raised, and not unless.

We have next to act on B by A.

There is this difference in the movements of

A and the rest of the series, that A, when it moves, must move very rapidly, the rest need not. The time taken up by each signal is composed of that which is required to deflect the needle and to move A; in proportion then as we diminish the latter, the addition of machinery to the telegraph will cause less additional delay. We have seen that the plan of A's movement is this: first, a *long* pause, then a quick down and up movement; B and the remaining arms may, on the contrary, occupy the complete time of each signal in making one up and down movement; all that is necessary being that B should be down on its supporting stop the moment A is let free to fall; that is, as we shall see, the moment it is liable to be raised. In fact, each complete up and down movement of B may (p. 15) take up any aliquot part of a complete signal. The slower B and the other arms move, the longer the signal will take in being transmitted through their series, but that is all.

To give A the required movements two teeth, or sliding cams, each like the one shown fig. 6, moving across it on opposite directions will suffice. Each will move backwards and forwards through the horizontal distance $g\ l$. When the point k is brought under A (seen here in section) A will begin to fall. If the needle check it, the projecting angle f will slide under A and lift it up, and make it also raise B, which lies just

above and almost touching it; if the needle does not check A it will fall down to *h*. The instant the vertical line *g h* comes under A, *b* must begin to act. If the teeth as represented in fig. 3 were those adopted for B, C, D, E, we should require different mechanism to move the teeth belonging to A, but not so if all the teeth acted crossways, as those in fig. 4.

The way in which signals pass through the machine.

The signals made by the needle travel through the series of arms not unlike messages do from semaphore to semaphore, in the old system of telegraphs. The signal is taken up by each arm in its turn, and each having forwarded it on to the next, drops back to its place. The last arm E moves as fast as the needle does, but at any one instant the movement of the last arm will have no reference to the signal which the needle at that time is employed about; it will correspond to one that has been made some time before: so the delay incurred by using a series of arms tells, once for all, upon the whole communication, and is not repeated at each signal. And as the last arm does not begin to move till two or three seconds after the needle has begun signalling, so it will continue moving after the needle has ceased, making up its arrears.

In the table fig. 7, we see the exact steps by which a signal (S) travels from one end of the mechanism to the other.

It is very interesting to watch such a series in

work; how the delicate, scarcely perceptible, touch of A causes an influence that travels on, almost as if by instinct, through the whole series; how each arm hands it on to the one above it, its available power increasing at each delivery.

The small arms need not turn on centres, they had better be springs, and also non-metallic. A series of five arms will be amply sufficient, without overtasking any of them.

Although only one example is given of a series of arms, yet a very great many other contrivances to accomplish the same end on identical principles will doubtless occur to any mechanic. The teeth may be replaced by other mechanism; we may use bolts of various kinds instead of arms, and they may act on one another by intermediate pieces. Still the plan described above seems in its general features as simple and as efficient as any we could hope to obtain.

Suppose that three types (*f*, *g*, *h*) set in a row, fig. 8, were attached to a table sliding within a frame, with a deeply grooved bar (L), having three transverse slits fixed upon it, the distance from slit to slit being the same as from type to type. In the right-hand slit let a flat bar (F) be secured; in the others let the bars G and H slide, the two last having each a hole in its middle. (See fig. 9.)

To the end A, B of the frame let there be fixed a rod R, so placed, and of such a size, that when

the table is pushed towards A B the rod will enter the groove of L, and also if G and H are both pushed as far as they can go towards B C, the rod will pass along through the holes in their centres, and allow the table also to be pushed on until F meets it. If, however, either of the slides be pushed as far as it can go, not towards B C, but towards A D, then it will block the passage and oppose the rod. So that if the table be alternately drawn to C D and then left to fall back under the action of a weight or spring, we can cause it to be checked at G or F as we like, by pushing one or other of the slides towards A D, or by letting them both alone. There being a contrivance (p. 17) for returning the slides to their places during each movement to the right of the tables.

Hence, by properly arranging a stamp, we can bring whichever of the three types we wish under it, the stamp being further contrived to fall the moment after the type has been so placed.

If then we connect the last arm of one series of arms with F, and the last arm of the other with G, and the movement of the table be so regulated with reference to these arms that the instant it is pushed forwards towards C D, and before it is released from its backward course, under the action of the spring, the teeth belonging to them are made to act.

Then according to the position of the needle, so the slide F, G, or H, acts, and the corresponding type comes under the stamp.

It is hardly necessary to remark that the addition of this table is, no more than that of the series of arms, any cause of delay in the rapidity of signalling.

In an ordinary two or three-needle telegraph the eye translates each different combination of their different positions into a different letter, and we shall show (p. 16) how this can be done by mechanism; but there are other points which now present themselves for our immediate consideration.

When the arm A falls upon the needle, we guard against its tilting it to one side, and also against any possible injury which the pivot might receive from the shock, by having a kind of flat fork (fig. 10) lying between the needle and its galvanometer, and made to lift it up, in the least possible degree, the moment A falls, replacing it instantly after the point of the cam-tooth is engaged with it. The needle kept from tilting.

Again, the current deflects the needle, but the machine must replace it. A pair of nippers, as in fig. 11, will do this: (O is a fixed point) as then the arm M moves up and down the nippers close or open. In closing they right the needle. The cam for making the nippers so act as to leave the needle quite still, requires to be To replace the needle.

carefully made; they should close quickly and begin to open steadily.

Needles balanced, not weighed.

By employing them we gain the great advantage of using balanced and not weighted needles. The same bias in the ordinary telegraph that tends to replace them when moved is, of course, in exactly the same degree a resistance to their being moved at all; and, again, machinery will replace a needle much quicker than any bias can.

We may here observe that it is impossible for the needle to get over either of the arms A, for the nippers have replaced it before they begin to rise, and have hold of it while they are rising.

To know how the distant Telotype is working.

In order that the operator may know how the distant Telotype is working, its stamp on descending makes contact, completing the circuit from the distant battery, excluding the distant Telope, and acting on one of the needles of the operator's Telotype. It will correspond to the answer of "understand," which follows each signal in the common needle-telegraph. The time during which contact is made, though short, will be sufficient, for a current adequate to make a needle swing may be almost instan~~eous~~ taneous; it is the swinging through a sufficient are that takes time. The operator's Telotype must, while he is working, have a piece of iron properly disposed, to give a bias to his needle by its attraction.

The table of relative movements, fig. 7.

A complete drawing of all these parts (showing their connections one with another) would be too confused to be of service, and indeed it is in no way required, for they may be put together in many different manners. But, what is more important, a table of their relative movements is given (fig. 7), by which indeed we can obtain a clearer notion of them than by an inspection of the machine itself. In the ~~The~~ table is represented one of the two series of arms that act on each needle; in it five movements of the needle are given, of which the first, second, and fourth, have checked A. The progress of the second signal through the machine is marked by the letter S.

The wavy line, whatever its position may be, indicates rest, and vertical distances refer in all instances to vertical movements, except in the cases distinctly specified on the right side of the table.

We might evidently make the complete movement of each arm except the first take up a half, third, fourth, or any other aliquot part of a second that we pleased, all that is necessary being to have each arm in a position to be acted on the moment the arm below is in a position to act upon it.

We here take leave of the first part of the Telotype. It has been amply explained how the Telegraph Needle can communicate with

heavy machinery, so that we have now no further difficulty about distance and the weakness of electric currents to trouble us, and for the present may dismiss them entirely from our minds.

If two or more needles act together, to cause a different letter to be printed for each different combination of their poitions.

Consider, then, that we have to contrive a machine that we may overlook as it works, capable of printing what letters we wish simply as the result of our touching certain keys at proper times. What lends an additional interest to this investigation is that, as has been suggested to the author, such a machine would be really useful. We shall see that considerable rapidity in printing can be attained, and also that two or three copies might very readily be printed at once. This part disconnected from the electrical part of the Telotype, would be a kind of copying-machine, and still more; for it would not only give two or three fac-similes, but would also produce them in a printed form.

We saw (p. 12) how, by pushing out the slide G or H, or neither of them, at the proper time, we could cause whichever one we pleased out of three types to be placed under the stamp. Now, we might have a series of tables, each table carrying a rod at one end and a set of slides at the other; or better, a contrivance like that in fig. 12, where each table has a set of slides at both ends, and a rod (R), as in the figure, common

to the two adjacent sets of slides on different tables, and connecting them together.

First, consider only the two sets F, G, H, and L, M, N. Let the distance between the adjacent slides F and G, G and H, be called 1, and that between L and M, M and N, be 3; next fix a row of nine types as before, but to the second table, and adjust a stamp properly over them, so that if the slides L and H act, the stamp falls on the first type. Then if L and G act it will fall on the second; if L and F, on the third; if M and H, on the fourth, and so on; lastly, if N and F, it will fall on the ninth.

That is, we cause a different type to be placed under the stamp for each different possible combination of slides that we can use, one slide out of each set; in fact, a different type for each different compound signal of the needles.

In a third set of slides the distance from slide to slide must be 9, in a fourth 27, and so on.

These tables are pulled out as far as the rods will permit them by the machinery, and when just at their farthest, by the last arms of each series then acting, the slides corresponding to the signal get pushed out; the tables are then let go; the proper type is in consequence placed under the stamp, which falls upon it. The stamp then rises, and the tables are pulled out again, and so on as before. The slides are replaced by a rod parallel to the grooved bars L, on the side B C, and

which moves up to them as the tables are being pulled out, so pushing back the slides.

The means by which the Telotype is worked.

The keys, which the operator signals with, bear each the letters corresponding to them. They are arranged like the keys of a pianoforte, and supposing that three needles were used, each having two signals beside its position of rest, we should have twenty-six keys. Running underneath them, let there be six parallel horizontal rods (R). Each of these rods are supported at either end on springs (S, fig. 13), and have metal points (P) attached to them by a spring, as in the drawing, each point lying just above a metal tablet (I). It will be sufficiently seen by the diagram, that if any key be pressed down upon a rod, the springs supporting it would yield at both ends, and the metal points would make efficient contact with the tablets. K is a section of the keys. Two of these rods would refer to one needle, one rod being pushed down would deflect it to one side, the other to the other.

The keys would rest on one or more rods, according to which combination of signals they were severally to give, and their shape would be as in fig. 14, where one is seen sideways, and the rods in section.

A printing machine.

In the case of using the Telotype as a simple printing-machine these horizontal rods would not have to make contact, but, directly or indirectly, to check the fall of the first arm (*A*). Or

even, not using the arms at all, to act at once upon the slides.

The above method for combining separate movements has been selected out of several that were tried with more or less success. Others, such as various ways of placing the types in a square, and making one set of signals move them in the "axis of x," and another in that of y, or even arranging sets of types in planes one above another, something like the lenses in old-fashioned pocket magnifying-glasses, the signals in x and y determining the position of the whole, and z pushing out one particular plane from among them, through an angle determined by the construction of the machine, and the same for all the planes, are all practicable, but appear never to have been attempted before.

A very efficient machine can be made with strips of wood, which the diagram, fig. 15, will sufficiently explain. The position of the slides, or rather of the moveable bolts, are indicated by the dots, and the fixed ones by the crosses. F is the force that replaces the type-holder. S, S the springs that move it when released by F. T the type-holder.

To ensure accuracy of position of the type under the stamp.

Whatever apparatus be used, any trifling inaccuracy of position in the type under the stamp can easily be rectified, by having two holes made in the type-holder corresponding to each type; into these, two conical plugs, attached to the

stamp, and projecting a little way beyond it, fit. These plugs will compel the type-holder to adjust itself properly, a little latitude of movement being, by any simple contrivance, such as a compressible cap on the rods which strike the slides, being given to it. This or any other similar way on the same principle will suffice. As to the way in which the types should be set, we can suggest no plan beside those that are already in use for different registering machines. The simplest appears to be one that has some time since been proposed in connection with the telegraph, where a strip of thin metal is cut into transverse slips, in shape something like a comb, to the end of each of which is fixed a type (fig. 16).

A compound Telotype.

In many cases it may be desirable to print two letters at a time, we should therefore require a double machine, and must arrange the type-holders (fig. 17) so that the types may lie closely side by side. With a different way of holding the types, as many letters as we could manage keys might, if expedient, be printed at each stroke of the stamp.

There would be of course a set of keys for each type-holder; the first set would determine the first letter, the second the second, and so on. Such a contrivance, from requiring so many wires, could hardly be advantageous for telegraphing, except for very short distances, but

would in all cases be best for a simple printing machine, like that alluded to, p. 16.

A second would be the utmost that a single set of signals would take; if, then, we could manage four letters at a time, we should print faster than we can write.

Again, to each type-holder, three or four others might easily be attached in line (*fig.* 17), so as to make the same number of copies.

The paper must of course be moved one step for each stroke of the Telotype. No methods different from those already in use for this or for inking the types are necessary. A diagram of this part of the machine is given in fig. 18. T represents the type-holders. K the inking-rollers. J the drums that carry the paper. S the stamp.

Distant circuits completed by *means of the* Telotype.

The Telotype can do more than print letters, it can direct electric currents through different channels. Thus, to take a very simple case: if we wished to ring a bell, the stamp might evidently be connected with one end of a new circuit, which, passing round the electro-magnet that is arranged to perform what we want, is fastened at the other end near to some particular type, so that when the corresponding letter is signalled the stamp shall, on descending, complete the circuit. But much more than this is practicable, and there can be little doubt but that if the Telotype be proved able to do what has

already been claimed for it, further refinement is well worth attempting, even at the cost of increased mechanism.

Suppose a convenient battery, say two Smee cells, attached to the *Telotype;* one wire goes directly by the side of the stamp, the other is divided into many branches passing severally round electro-magnets K, N, Q, and then going to the side of the types *k*, *n*, *q*, respectively. Now it will appear that we have the power of determining from a distance whether, when we signal the letters *k*, *n*, *q*, the wires in connection with them shall, or shall not, have their circuits completed. The following method will explain the principle on which we must proceed. Our object is to contrive that contact shall be made only after a certain set of signals had previously been made. Suppose we choose the letters *p*, *l*, *t*, as "key letters," they would never be wanted together in signalling words, and it is very unlikely that that particular combination should be made by inadvertence or accident of any sort.

Now suppose that we had as many arms (fig. 19) as there are to be key letters, three in the present case, which we will call L, P, T, respectively, and represented in fig. 19. They can all turn, but not too freely, through a small angle round an axis that passes through C.

These arms and the box in which they are placed, are of non-conducting material, but an

arrangement is so contrived that when all the arms L, P, T, are pushed up on the left hand, metallic communication shall *extend from* P through A to a point B, corresponding to A, on the opposite side of the box. This is so simply done by having a metal point on each arm and one attached to a spring on each partition, that a drawing, especially as it would be rather confused, is unnecessary. Then the wire, described as above as going to the stamp, is attached to B, and the box is fixed to the side of the stamp S, P lying just above the end of the wires coming from K, or from N, or from Q, according as the stamp is above one or other of those letters.

If, then, the three arms be pushed up to the left, P will, on the stamp descending, complete a circuit through the electro-magnets K, or N, or Q, according to which of the letters *k*, or *n*, or *q* has been signalled.

It remains, then, to show how we can contrive that the three arms L, P, T, shall never be pushed up together on the left side, unless the letters *l*, *p*, *q*, have been signalled together just before. Let the arms be of the same length on the right side, but of different lengths, as seen in the diagram, fig. 19, on the left side. Let there be a bar, X Y, on the right side extending the whole length of the types, but intercepted at points a little beyond the types *l*, *p*, *t*, so that when the stamp descends on any type except

those, the arms L, P, T are pushed up to the right by it. Again, at points opposite these interceptions let there be projecting teeth, one at each point, and so placed that when the stamp descends on l, L gets pushed up to the left; when on p, P; and when on t, T. If these three letters have been signalled together, not necessarily in succession, but without any other signal having intervened, all the three arms L, P, T will be pushed up on the left. The circuit then is complete between A and B (fig. 19). Now suppose the stamp to descend on q, as it falls, the circuit will be complete through the electro-magnet Q, whose armature will be lifted; but when the stamp has reached the type, the bar X Y will have come in contact with the right side of the arms L, P, T, and pushed them all back again. To make any other circuit, the letters l, p, t, must again be signalled before it can be done.

This example will show how key letters may be employed. The details must be varied a little when two or more type-holders are used.

We will add nothing further on this branch of the subject, except that we can do what we like by means of the Telotype if we choose to make the necessary mechanism, for we can get force and have the power of directing it as we please.

To set the distant Telotype in motion.

It would be a great waste of power to let the whole machinery of the Telotype be always

working; we must, therefore, consider plans for starting it at will, and for ensuring its stopping when left alone.

It will be held in restraint by an ordinary detent that is so acted on by a spring as to keep to whichever side it is pushed. When the detent is pushed down the machinery will be stopped, when up it will be released.

For striking the detent up we must obtain an intermittent force of sufficient strength to do it, and yet requiring but little expenditure of force to sustain it when once set in action. Having this, we cause two or three arms (A', B', C') to work in connection with it, on the principle of the arms A, B, C, in the first chapter, C' being pushed into the path of a tooth urged by the intermittent force, or not, according as the descent of A' has or has not been checked by the needle, which is one of the ordinary signal needles in the Telotype. If C' be in the path of this tooth, it will be struck by it against the detent and force it up. Now, there can be no more suitable contrivance for this intermittent force than a common heavy pendulum; it will be kept in motion by some simple clock-work, which will also have to keep in constant motion the arms A', B', C'. These, as we do not want quick motion now, may be nearly balanced on their centres, and will require, therefore, but little extra force to work them. A' must be shaped as in fig. 20; for as we do not know

whether it be up or down when we make the signal, we should otherwise endanger the needle getting above it, which would set all wrong, unless we made a pair of nippers act at every beat. In connection with the detent should also be a light cam, which, when the detent is pushed up, passes underneath 'A', lifting it up, for as long as the machine continues acting, quite out of the way of the needle. When the detent falls it moves back, and permits A to fall too.

To stop the distant Telotype.

The best way of causing the machine to stop is to give up the first signal for the purpose, and instead of having a type at the point which comes underneath the stamp when none of the needles move, to have a projecting tooth by the side of it. This will strike any simple contrivance attached to the stamp, which will push down the detent, and stop the machine.

To supply power to work the Telotype.

We must now consider the most convenient method of supplying power to work the Telotype. Beside using heavy weights, we may avail ourselves, in towns, as has lately been suggested for other purposes, of the water power in water pipes. We might also supply power from branch offices. Power can be transmitted through very considerable distances with but little loss, by means of rods of wood connected by cranks, not unlike the way in which common bell-wires are hung, but made to push as well as to pull. Chains of communication of this sort, starting from a water-

wheel in one valley, over mountains, to work machinery in another, must frequently have arrested the attention of tourists in the salt districts of the Tyrol, passing as they do alongside the mountain roads. And here, at railway stations, we see how a man can govern a signal some hundred yards from him, through means of a long wire, with great facility.

It does not seem more inconvenient to supply houses with force to work their Telotypes than with wires to transmit the currents, for the rod that transmits the force would run alongside of the wires, and occupy but little more space than they.

At all events, the machine, whatever it may be, need not be in the same room with the Telotype, but, working in any convenient place, have its force sent on. A stout bell-wire would be amply sufficient to transmit the required force from a room not too far distant.

The machinery would of course be regulated by a governor of some description; and as we can, by means of the electro-magnets mentioned above, command any movement we like, no mechanical difficulty stands in the way of the operator regulating as he likes the speed of a distant Telotype. He might act on the governor, which would alter the speed of the whole machine, or he might act on a set of "change-wheels," which connect the Telotype with the power that works it.

If telegraphs that printed satisfactorily were once found practicable, most large houses, public and private, would soon become supplied with them. The communication being so immediate, answer following question as fast as it is put, affords much more nearly the advantages of a personal interview than the best regulated Post-Office ever could. Any scheme to introduce such telegraphs generally, would probably be first confined to London. There would be central offices, and from these bundles of wires would radiate to numerous branch offices. From the branch offices again wires would pass along adjacent streets, supplying houses as they passed. The batteries might or might not lie at the offices; if they did, of course twice as many wires must enter the house as otherwise would. The expense of distributing wires in this way could not be extreme. If such a scheme ever became general, and the branch offices were as numerous as the branch post-offices, the distance that the wires private to each house would have to traverse could never be so great as to make the undertaking too costly. As an example how one house would communicate with another, let C be the central station, A a house in wire-connection with the branch office B, and A_1 with B_1. Then A signals to B to connect its wire with C; then to C to connect it with B_1, next to B_1, to connect it with A_1, and the chain is complete.

Having arrived thus far we will close these

pages by offering a few further suggestions to the test of experiment.

The different signals one needle is able to give.

If a single wave of electricity be sent along a wire, let us consider if it be possible so to modify it as to obtain a greater variety of signals than that of a simple movement of the needle to the right or the left. Besides sending a positive or a negative current, we may also send a current of greater or less electro-motive power, and we may send any current at perceptibly differing intervals of time. This, in our present state of electrical knowledge seems to be all that we can do. How far these two last may be made available for the Telotype we are now about to consider.

Let the needle, before striking the stops p, q, which limit its motion, strike one of the rods (fig. 21), the dotted line representing the path of the needle. To whichever side either rod be pushed it evidently will lie; and their weight and balance may be so regulated that the ordinary force with which the needle swings against them shall not affect them, while a greater force shall throw them over. These bent rods can have their system of arms, A, B, C . . . just as the needle itself has, but one system of arms only need act upon them, while two act upon the needle. Second bent rods might even be contrived to lie between the first bent rods and the limiting stop. Instead of these a series of armatures, attracted by an electro-magnet, might possibly be found more

manageable as to variations in time. Besides the arms A that fall one at each end of the needle, a third arm, A', itself ~~also~~ the first of a series, should also fall, but a little before the others, though raised again at the same time with them; so that if the needle move in time it will intercept both.

The degree to which these methods can practically be used will be decided alone by experience. It is easy to work with them through a short circuit, quite sufficiently so as to make them well worth a more extended trial; indeed, all must agree that few objects in Telegraphy are more important than to develope the powers of a single wire as much as possible.

If we used only one "Time-Arm" and one "Power-Arm," each wire could give 8 signals besides that of rest. For each additional arm we should multiply the 8 by 2, and, of course, on using any at all, more tables would be required.

To work each additional battery power an extra horizontal rod lying under the keys is necessary, but for each variation in time we only require different lengths of the catch under the keys. Where the catch is long the circuit is completed almost the moment the finger begins to press; when short, not until the key is fully pressed down. To manage this properly a practised touch is of course required in the operator. The strength of the battery would here have to be regulated before starting. Possibly a cheaper

method, and yet equally as good a one as that of using a resistance coil after the manner of the Rheostat, might be obtained by having two metal plates of considerable surface, say a foot or foot and a half square each, lying parallel to one another in fluid, contained in an insulated vessel; one end of the wire being attached to one plate and the other to the other. The current would pass sufficiently well through the fluid, and probably by altering the distance of the plates, through means of a screw of some sort, the resistance would vary with sufficient certainty and rapidity to make it available.

If we used two strengths of current we should pass it through the water for the weak current, and directly from wire to wire for the strong one. These suggestions are merely offered as such, as they have never been tried on actual telegraphic wires, or indeed with telegraphic batteries.

To insulate wires, in a bundle, from one another.

For insulating wires from one another when several lie side by side in a bundle, the following method has been tried. It is an obvious one, but does not appear to have hitherto been thought of:—A non-conducting tissue or sheet of any kind (T, fig. 22) is passed over a roller (R_2); above it is passed from a second roller (R_1) a set of parallel wires (W) in the same plane with one another. These are pressed on the sheet by a third roller (G_1) that is slightly grooved, and which crimps the sheet between

the wires; then over a fourth roller (G_2) that crimps it still more, and so on until the wires and the sheet are as in fig. 23, or by having wires on both sides of the sheet they may be as in *fig.* 24. A number of bands like this may be made at the same time by a compound machine, in planes parallel to one another, and then brought flat, with fresh sheets between them, through two other rollers, and afterwards secured after any well-known method together. The tissue being steeped in adhesive non-conducting fluids will, of course, promote the strength of the whole.

Conclusion. At this point we will conclude with simply remarking, that though the Telotype is a machine of some complexity, it is nevertheless very symmetrical, and there is hardly a part of it which requires any but the commonest workmanship. It appears to be pre-eminently a machine, itself to be made by machinery, and not by hand. The expense of a good working instrument, when devised into a compact form, could scarcely exceed that of a common watch. But experience alone must decide on all these matters; and it is with an earnest appeal to experimenters to test them fully and fairly, and a real desire to advance an important branch of practical science, that these contrivances are neither withheld nor patented, but given to the Public.

Printed by T. Brettell, *Rupert Street, Haymarket.*